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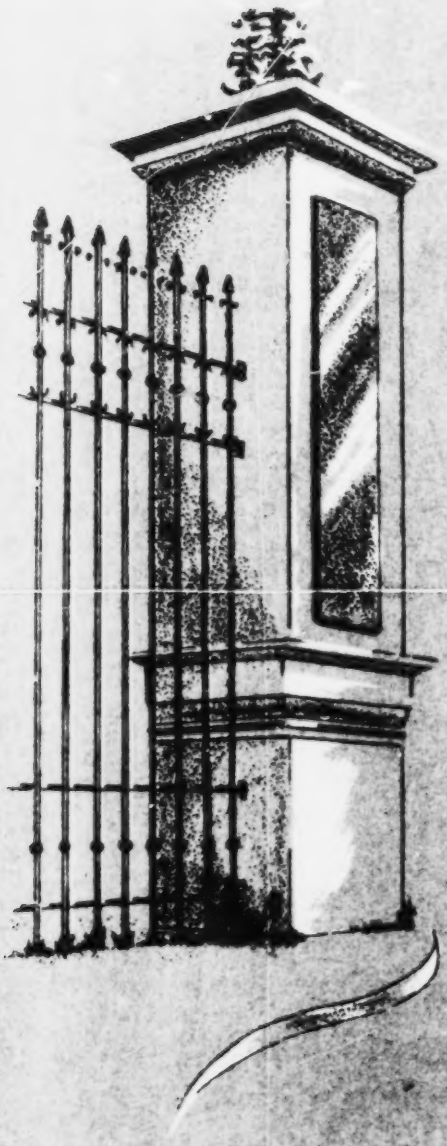
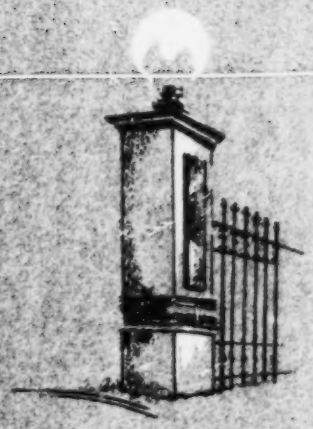


university curriculums and fellowships in radiological health



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Environmental Health Service

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This booklet was edited and prepared for printing under the supervision of the Training Grants Officer, Grants Office of the Bureau of Radiological Health.

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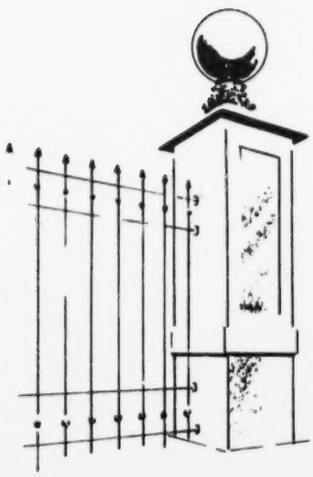

university curriculums and fellowships in radiological health

The Bureau of Radiological Health acknowledges the contribution made by the project directors of the respective schools in supplying information on their individual programs.

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Radiological Health
Rockville, Maryland 20852

FOREWORD

The Bureau of Radiological Health, Environmental Health Service, is responsible for planning, conducting, and coordinating a national program for the evaluation and control of radiation hazards so that the benefits of radiation may be achieved without undue risk to health. Efforts to provide an adequate national resource of trained manpower to meet this objective have always been one of the major thrusts of this activity. The radiological health manpower development activities are carried out through a program of continuing education in the form of short courses and through grants and contracts to educational institutions for the development and support of appropriate programs.

The Radiological Health Training Grants Program funds are used to strengthen and extend programs of basic instruction, to add to the faculty and its supporting staff, to secure equipment, and to encourage greater enrollment by providing financial assistance to qualified students preparing for careers in radiological health. The supported projects operate at two academic levels, Radiological Health Specialists (graduate) and Radiological Health Technicians (undergraduate). This booklet has been prepared to describe the academic programs funded through these grants. This information should be of assistance to educational institutions considering the development of programs in this area and to students considering educational opportunities.

John C. Villforth
Director
Bureau of Radiological Health

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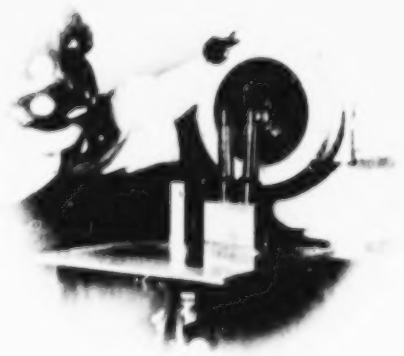

INTRODUCTION

Unusual career opportunities exist in radiological health for personnel having basic degrees in physics, chemistry, biology, engineering, or other related disciplines. There is a critical need for professional personnel to plan, develop, and direct radiation protection programs in conjunction with the rapidly increasing use of radionuclides and other sources of radiation; to measure and control radiation in the environment; to investigate and develop techniques for reducing radiation exposure from electronic products and medical and dental x rays and to perform research related to the radiological health programs.

The Radiological Health Training Grant Program was created in 1961, in large part to provide the training mechanism necessary to meet the national need for radiological health specialists and technicians, as projected by the National Advisory Committee on Radiation (NACOR) in its first report to the Surgeon General in 1959. The educational format of the grant program is based on the public health and radiation sciences core curriculum, recommended by the participants of the 1960 Princeton Symposium on "University Curricula in Radiological Health." This training, it is generally agreed, should include study in radiobiology, atomic and nuclear physics, hazards evaluation, epidemiology, biostatistics, and other areas of radiation science and public health. The curriculum is designed to prepare radiological

health specialists and technicians for professional positions in radiation protection programs.

Today there are a large number of educational institutions (see table of contents), well-distributed geographically, with curriculums for specialists and technicians in radiological health. These study programs or training projects, described in some detail in this booklet, have been developed with grant assistance from the Bureau of Radiological Health. All of the participating schools offer financial assistance to qualified candidates.

All inquiries concerning admission to a selected university, clarification of its curriculum, the availability of financial assistance, and related matters should be addressed to the project director designated in the program description.

Questions concerning grants to institutions in support of radiation health specialist and technician training programs should be addressed to Director, Bureau of Radiological Health, Environmental Health Service, 5600 Fishers Lane, Rockville, Maryland 20852.

RADIOLOGICAL HEALTH FELLOWSHIPS

Radiological health fellowships generally include a provision for waiver of all tuition and fee charges, as well as payment to the student of a stipend or monthly support allowance.

SPECIALIST PROGRAM DESCRIPTIONS

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UNIVERSITY OF ARKANSAS MEDICAL CENTER

LITTLE ROCK, ARKANSAS

graduate degrees

Master of Science with a major in Radiological Health

prerequisites

A Bachelor of Science degree in any of the sciences such as biology, chemistry, physics, mathematics, engineering, or pharmacy; a grade point index of at least 2.50 (A=4) for undergraduate work; acceptance by the University of Arkansas Graduate School and by the Director of the Radiological Health Training Program.

curriculum

First Year:

First Semester:

Epidemiology
Isotope Tracer Technology
Isotope Laboratory
Biometrical Methods I
Seminar

Preceding page blank

Second Semester:

Public Health Administration
Health Physics
Health Physics Laboratory
Biometrical Methods II
Radiation Chemistry
Radiation Biology

Summer Session:

Thesis Option:
Research and Thesis

Nonthesis Option:
Graduate level science electives
Comprehensive oral examination

Second Year:

First Semester:

Research and Thesis
Advanced Nuclear Instrumentation

Electives which are available include:
Special Topics in Nuclear Chemistry
Nuclear Power Plants
Biophysics I & II
Biometrical Methods III (Experimental Design)
Introduction to Biomedical Computing

Practicum:

Students in this training program will visit the Oak Ridge National Laboratory and the Training Laboratory of the Oak Ridge Associated Universities. During this 1-week trip, students will participate in experiments and will hear lectures by scientists engaged in various phases of Health Physics.

Research Opportunities:

The University of Arkansas is one of the sponsoring institutions of the Oak Ridge Associated Universities. Through this association, it is possible for staff

members and graduate students to study and to conduct research at Oak Ridge. Opportunities for research in Radiation Chemistry, Radiation Physics, and Radiation Biology exist at the University Medical Center and at the Graduate Institute of Technology.

objectives

The purpose of this Radiological Health Training Program is to offer an academic program which will furnish the education and training requirements of persons interested in pursuing careers in Radiological Health. Strong emphasis is placed on measuring and controlling radiation in the environment and on investigating and developing methods for reducing radiation exposure.

Address all communications to:

Charles E. Breckinridge, Jr., Ph.D.
Chairman, Department of Radiation Sciences
School of Pharmacy
University of Arkansas Medical Center
Little Rock, Arkansas 72201

UNIVERSITY OF CALIFORNIA

LOS ANGELES, CALIFORNIA

graduate degree

Master of Sciences in Medical Physics (Radiology)
Doctor of Philosophy in Medical Physics (Radiology)

prerequisite

A bachelor's degree in physics, chemistry, biology, or its equivalent from an accredited college. Applicants are expected to have had courses in physics, chemistry (including organic and biochemistry), biology, and mathematics (2 years of calculus). A limited number of these courses may be taken after admission.

curriculum

Majors in Medical Physics are required to demonstrate a competence in the subject matter covered in the following course areas:

Radioactivity-Isotope Methodology (lectures and laboratory)
Clinical Applications of Medical Physics (Nuclear Medicine, Diagnostic Radiology, Radiation Therapy)
Radiation Biology
Radiation Physics (lectures and laboratory)
Dosimetry and Health Physics
Genetics
Biostatistics

Public Health Administration
Epidemiology
Elementary Quantum Mechanics (Physics Department)
or
Quantum Chemistry (Chemistry Department)

objectives

The Department of Radiology offers opportunities for advanced study and training in the general fields of radiation biology, radiation physics, and the clinical use of radioisotopes. Programs leading to a Master of Science degree and a Doctor of Philosophy degree in Medical Physics are open to qualified students who have majored in physics, chemistry, or biology. The emphasis of this program is on the basic radiological sciences, radiation physics and radiation biology, and on their application to basic problems in biology, medicine, and environmental health. Opportunities for research in other fields of medical physics are also available.

The Department of Radiology has extensive facilities for both basic scientific and clinical research. Among these are chemistry and physics laboratories, a "hot" laboratory, a tissue culture laboratory, a walk-in refrigerator, departmental library, and radiation sources. In addition, extensive supporting services are furnished by the medical center and associated campuses of the University including a large biomedical library and a machine and electronics shop; also a computer facility, a number of accelerators for electrons and protons, nuclear reactors with steady state and pulsed capabilities.

Address all communications to:

Dr. M. A. Greenfield
Department of Radiology
Center for the Health Sciences
University of California
Los Angeles, California 90024

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

graduate degrees

Master of Science: Radiological Science (specialty of Radiologic Physics and Radiology Administration); Nuclear Engineering, Sanitary Engineering and Environmental Health (specialty of Radiation Health)

Doctor of Philosophy: Nuclear Engineering and Environmental Health (specialty of Radiation Health)

prerequisite

A bachelor's degree in the sciences and a satisfactory score in the graduate record examination.

curriculum

Fulfillment of requirements of the designated department (Radiology, Nuclear Engineering, Sanitary Engineering, or Environmental Health) for the advanced degree; in addition, course work listed below:

Physiology and Biological Chemistry
Radiological Sciences Laboratory
Health Administration
Radiobiology
Epidemiology
Radiation Health
Biostatistics

objectives

The objective of the program is to provide a graduate radiation health specialist training curriculum. The trained personnel will be of caliber capable of developing effective radiological health programs in Federal and State agencies, in industry and in medical centers.

The radiologic physics course of study will emphasize the physical problems related to the applications of ionizing radiation in clinical medicine (primarily in Departments of Radiology). The students thesis research for the master's degree will consist of an approved project related to radiologic physics (for example, radiation biology, radiation therapy, diagnostic radiology, and so forth).

The radiology administration program is designed to give the student a strong academic background in radiologic sciences and management aspects coupled with practical experience. The quarter preceding and the quarter following the academic year of study will be spent as a practicum in the Department of Radiology. This training will include fundamentals of radiographic exposure, equipment usage, and standardization of operation. The student will rotate through supervised programs in various types of radiology departments (university medical complexes, community, pediatric, and so forth). The student will also be required to complete an experimental project within the department (no thesis will be required).

Address all communications to:

James G. Kereiakes, Ph.D.
Professor of Radiology (Radiologic Physics)
Radioisotope Laboratory
Cincinnati General Hospital
Cincinnati, Ohio 45229

COLORADO STATE UNIVERSITY

FORT COLLINS, COLORADO

graduate degrees

Master of Science, Doctor of Philosophy

prerequisite

An undergraduate degree from a recognized college or university with a major in one of the science fields. This must include a minimum of 15 quarter credits of biology, an adequate foundation in college mathematics, 15 quarter credits of physics, and sufficient chemistry to have completed a course in quantitative chemistry and a course in organic chemistry or biochemistry. Applicants are urged to furnish scores from the Graduate Record Examination.

curriculum

The Master of Science degree requirements include most of the courses listed below as "recommended courses for the M.S. degree." The most prevalent requirement involves the above mentioned course work plus a library research report taking 4 quarters (12 months) of study. In certain cases a thesis can be required based on master's research for a total of 5 to 7 quarters of study. The radiation health practicum gives 1 quarter of experience in typical state radiation health activities plus 1 week's experience in Health Physics at the Idaho Falls Nuclear Reactor Test Site.

The Doctor of Philosophy degree requirements include the courses listed below as "recommended courses for the MS. degree." In addition, a year of advanced study in physiology,

biochemistry, and/or other areas is required. Two years of Advanced Radiation Biology and 2 years of Radiation Biology Seminar complete the core curriculum. The course work plus the necessary research for the dissertation usually covers a period of 4 to 5 years following the bachelor degree.

Recommended courses for MS. degree:

Introduction to radioisotopes
Radiochemistry
Radiobiology
Radiation public health (administration and epidemiology)
Radiation dosimetry
Radiation physics for radiologists
Radiation environment surveillance
Special problems in radiation health
Inferential statistics
Variance and covariance
Radiation health practicum
Radiation detection electronics
Radioecology
Industrial hygiene chemistry

Elective courses in:

Pathology
Statistics
Modern physics
Physiology and biophysics
Genetics
Physics
Biochemistry
Anatomy
Chemistry
Radiology
Public health
Advanced radiation biology
Radiation biology seminars

objectives

The radiation health—radiation biology—radiology program at Colorado State University covers a broad area, including the effects of ionizing radiation on living tissues, the use of radioactive isotopes as tracers in biological studies, radiation physics, radiochemistry, radiology, and other similar fields. Strong programs of research are established in cellular and subcellular radiation biology, wildlife and domestic animal radioecology, practical health physics (such as (1) uptake of radon daughters in lungs of miners and (2) movement of polonium in a soil-plant-animal ecosystem), radiology, and long-term radiation

effects on beagles. These research programs are the basis for dissertation research for the Doctor of Philosophy students.

The first year Master of Science degree program is strongly oriented towards giving the students a broad background in Radiation Health in order to fill the need for these types of personnel in hospitals, State and Federal public health departments, industry, and universities. Those first year students who show aptitude for research are encouraged to continue on for the Ph.D. degree in an area of basic radiation health science.

Address all communications to:

Keith J. Schiager, Ph.D.
Director, Environmental Health Services
Colorado State University
Fort Collins, Colorado 80521

UNIVERSITY OF FLORIDA

GAINESVILLE, FLORIDA

(College of Engineering)

graduate degrees

Master of Science in Engineering (thesis)
Master of Engineering (nonthesis)
Doctor of Philosophy

prerequisites

A bachelor's degree in engineering or one of the sciences, a "B" average or better during the junior and senior years and a satisfactory score on the graduate record examination.

curriculum

Program for Master's Degree

Radiological techniques
Health physics
Seminar in radiation biophysics
Atmospheric pollution
Environmental chemistry
Environmental biology
Radiological physics
Nuclear, x-ray instrumentation and dosimetry
Water quality management
Statistical methods in research
Research and thesis (MSE)
Electives

Doctoral study consists of the independent mastery of the field of radiological health, the acquisition of related environmental engineering concepts and the successful prosecution of scientific research. The course work required of the Doctoral candidate is therefore designed to meet both his research and career objectives.

Past experience has shown that the following post-Master program is typical:

Radioactive wastes
Radiation, uses in diagnosis and treatment of disease; effects on humans
Nuclear physics
Doctoral research
Electives
Environmental health practice
Microbiology of waste treatment
Environmental micrometerology
Toxicology, physiology and epidemiology
Experimental design in research

objectives

The study of radiological health is neither formal nor static. The task becomes one of bringing together pertinent basic information from many diverse disciplines and applying these fundamentals to current trends and developments. There are a number of departments at the University of Florida that offer ancillary courses related to radiological health, including biology, chemistry, nuclear engineering, physics, and radiology. A student and his advisor routinely formulate a distributed nuclear science minor from appropriate courses offered by several of these cooperating departments. By providing this individual flexibility, graduates will be best prepared for their specific career objectives.

All candidates for the master's or doctor's degree in the Department of Environmental Engineering are expected to have strength in traditional environmental engineering. The department offers many other courses on the various aspects of water supply, wastewater treatment, air pollution, water resources, and environmental health. Several of these courses provide insight into the transport of radioactivity through man's environment and are, therefore, available for major credit.

The student of radiological health at the University of Florida is especially fortunate in that both the College of Engineering and the College of Medicine have active programs in this general area. Basic training in health physics and the medical applications of radiation is provided in cooperation with the program in radiation biophysics of the Department of Radiology. Therefore, the students (1) are exposed to both the medical and the engineering points of view, (2) work with a wide variety of modern facilities, (3) receive instruction on the most up-to-date theories and techniques, and (4) have a broad spectrum of research opportunities. In addition, the facilities of the University of Florida Training Re-

actor, the Computer Center, the Kilocurie Cobalt 60 Irradiators, and the Nuclear Sciences Center are available for special training and research. These combined facilities, all on one campus in a salubrious climate, offer exceptional opportunities for graduate study in radiological health.

Address all communications to:

Herbert Bevis, Ph.D.
Department of Bioenvironmental Engineering
University of Florida
Gainesville, Florida 32601

UNIVERSITY OF FLORIDA

GAINESVILLE, FLORIDA

(College of Medicine)

graduate degrees

Master of Science in Radiation Biophysics

prerequisite

A bachelor's degree in mathematics, engineering, or the physical or biological sciences and a satisfactory score on the graduate record examination.

curriculum

The minimum registration required for the Master of Science degree is 45 credits including no less than 36 credits of course work and 9 credits of thesis. (Credits are based on the quarter system.)

Basic courses:

Radiological physics
Health physics
Instrumentation and dosimetry in Radiology
Radioactive tracer instrumentation and methodology
Radiation effects on humans
Computer applications in medicine

Seminar in radiation biophysics
Problems in radiation biophysics
Research and thesis

The following are some of the electives available:

Radiation biology
Physiology
Radioisotope methodology
Nuclear chemistry
Nuclear engineering
Nuclear physics
Nuclear power reactors
Nuclear medicine techniques
Statistics
Biochemistry
Cellular and molecular biology
Cytology
Radioactive wastes
Meteorology and air pollution

objectives

The radiation biophysics program is in the Radiology Department of the College of Medicine. The program emphasizes hospital or medical radiation physics, radiobiology, and health physics.

Well-trained radiological health specialists have multidisciplinary backgrounds. For a program to offer the broad background necessary it must have the close cooperation of the departments representing allied disciplines. Our program is fortunate in that it is located on the same campus as all the disciplines essential to the program and has excellent working relationships with all colleges and departments.

Emphasis is placed on research as well as practical training. Practical experience is gained by actual participation in a broad university radiation control program.

Facilities available at the university for support of research and practical experience include a nuclear science research center, in addition to a nuclear reactor, a 4-Mev positive ion Van de Graaff accelerator, two whole-body counters, a 2-Mev Van de Graff x-ray generator, several neutron generators, several multicurie Cobalt 60 and Cesium 137 irradiators, and the diagnostic, therapeutic, and nuclear medicine facilities of the Radiology Department.

A new Veterans Administration Hospital, which also has excellent nuclear medicine facilities, has just been completed adjacent to the College of Medicine.

Address all communications to:

Dr. Billy G. Dunavant
Department of Radiology
College of Medicine
University of Florida
Gainesville, Florida 32601

GEORGIA INSTITUTE OF TECHNOLOGY

ATLANTA, GEORGIA

graduate degrees

Masters of Science and Doctor of Philosophy

prerequisites

A bachelor's degree in engineering or one of the sciences; admission to the Graduate School of Georgia Technology.

curriculum

The program consists of four major parts:

I. The core curriculum of courses fundamental to the study of nuclear science and technology for all candidates. The suggested, tentative core curriculum, totaling 30 quarter-hours, includes:

Biological effects of radiation
Industrial hygiene and toxicology
Radiological health
Public health administration and organization
Radiochemistry
Principles of nuclear physics
Detection of radionuclides in water
Disposal of radioactive wastes

II. Courses in the student's major field with emphasis on topics closely related to nuclear science and technology.

III. Special problems or a thesis dealing with the application of the student's major field to nuclear science or technology.

IV. Courses outside the student's major field but of value to the candidate as a nuclear engineer or scientist.

Depending on the candidate's background, the program may take from 1 to 2 years for completion and will become part of the candidate degree program.

The exact title of the degree to be conferred upon the graduate will also depend upon his background and major field of specialization and may be either the M.S. or Ph.D.

objectives

The program at Georgia Tech is truly interdisciplinary, being administered by a committee representing the various contributing disciplines. Academic and research staff from the various schools on campus provides qualified personnel to teach the core curriculum and related courses as well as to direct research.

In addition to the Engineering Experiment Station, there are three activities of particular interest to the program and include:

I. A modern radioisotopes and bioengineering laboratory for teaching and research in the biological sciences, sanitary engineering, nuclear engineering, and physics. A 1-MeV Van de Graaff accelerator, a subcritical assembly and reactor simulator, and a 12,000-curie radiation source of Cesium 137 are available.

II. The new Nuclear Research Center, containing laboratory facilities for teaching and research and a reactor similar to that located at the Brookhaven National Laboratory.

III. The Sanitary Engineering, Public Health, and Applied Biology Programs affording additional training and research in radiological health, sanitary biology and chemistry, radiobiology, and environmental radiation surveillance.

Address all communications to:

Mr. F. W. Chambers, Jr.
School of Nuclear Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

HARVARD UNIVERSITY

BOSTON, MASSACHUSETTS

graduate degrees

Master of Science (Radiological Health)
Doctor of Science (Radiological Health)

prerequisites

Experience has shown that radiation assessment and control requires men and women trained in a variety of basic disciplines. For this reason, scientists, engineers, physicians, and liberal arts graduates with major studies in physics, chemistry, mathematics, biology, or pharmacy are encouraged to consider this program. Completion of the requirements for the Master of Science degree usually requires 2 academic years of full-time study; however, applicants with honor grades and adequate training in physics, biology, chemistry, and mathematics, supplemented by relevant professional experience in radiological health, can meet the requirements for the master's degree in 1 year. Completion of the requirements for the doctoral degree normally requires an additional 2- to 3-year period of study.

curriculum

Basic Radiological Health Courses

Introduction to Radiation Protection
X-ray Protection
Radiation Biology
Problems in Radiation Dosimetry
Radiation Protection Engineering

Additional Basic Courses

Biostatistics and Epidemiology
Human Physiology
Identification and Measurement of Air Contaminants
Aerosol Technology
Basic Problems in Occupational Health and Industrial Environments
Environmental Control

Supplementary Courses

Statistical Methods in Research
Operations Research in Environmental Health Engineering
Radiochemistry (MIT)
Principles of Toxicology
Environmental Physiology
Meteorological Aspects of Air Pollution
Legal Protection of Environmental Quality

objectives

The radiological health program of the Harvard School of Public Health is designed to help meet the growing need for people who can offer leadership in the evaluation of radiation hazards and in coping with the many health problems associated with atomic and nuclear operations. The curriculum is strongly research oriented. Such activities currently emphasize reactor and nuclear facility safety, treatment and removal of airborne radioactive contaminants, evaluation of the biological effects of internal emitters, and studies on the mechanisms of radiation damage. Research can be performed solely within the Departments of Industrial Hygiene and Physiology, or on a cooperative basis with other Departments of the School of Public Health or with the staff of the Northeastern Radiological Health Laboratory, one of the regional facilities of the Bureau of Radiological Health, U.S. Department of Health, Education, and Welfare. Experimental facilities available include the Cambridge Electron Accelerator, the MIT Research Reactor, the Harvard Air Cleaning Laboratory, and the University Health Services Environmental Health Laboratory.

Address all communications to:

Dade W. Moeller, Ph.D.
Harvard School of Public Health
665 Huntington Avenue
Boston, Massachusetts 02115

THE JOHNS HOPKINS UNIVERSITY

BALTIMORE, MARYLAND 21205

graduate degrees

Master of Science, Doctor of Science, Doctor of Philosophy, Doctor of Public Health

prerequisites

Candidates will be chosen from applicants who have an M.D. Degree or a BS, MS, or Doctor's Degree in the Physical Sciences, Biological Sciences, or Engineering. The candidate's academic experience should include basic college-level courses in mathematics through calculus, physics, chemistry, and biology.

curriculum

The work offered in the Radiological Sciences is divided into three categories: (a) a series of intensive courses at the basic science level in radiobiology, radiation physics, and radiochemistry: (b) a series of applied science courses in radiation protection and radiation control and public health; and (c) original research. All candidates are expected to take certain of the basic required work offered by the School of Hygiene and Public Health in its Master of Public Health curriculum. The following is a partial list of subjects covered by courses in the School: radiation physics and dosimetry, radiobiology, nuclear instrumentation, radiochemistry, cyto-techniques, radiation control, biostatistics, environmental medicine, epidemiology, public health administration, sanitary engineering, pathological physiology, physiological chemistry. Additional courses are available to the student in the several Divisions of the Johns Hopkins University and opportunities for field experience at various radiation facilities exist. Candidates are required to take part in a departmental seminar program.

objectives

The Department of Radiological Science provides a broad program of graduate education in both the theory and application of radiobiology, radiochemistry and nuclear medicine, radiation physics, and radiological health. The program is planned primarily for persons who wish to prepare for careers of teaching and research in the Radiological Sciences.

Address all communications to:

Dr. Russell H. Morgan, Chairman
Department of Radiological Science
School of Hygiene and Public Health
The Johns Hopkins University
615 North Wolfe Street
Baltimore, Maryland 21205

UNIVERSITY OF KANSAS

LAWRENCE, KANSAS

graduate degrees

Master of Science in Radiation Biophysics
Doctor of Philosophy in Radiation Biophysics

prerequisites

For M.S. degree: A baccalaureate degree in physical or biological science including a year each of physics and chemistry, mathematics through calculus and a course in biology.

For Ph.D. degree: Courses required for the M.S. degree (except research and thesis).

curriculum

Master of Science in Radiation Biophysics:

Radiation Protection
Radiation Instrumentation
Radiation Detection Electronics
Epidemiology of Radiation
Health Physics Laboratory
Radiation Biology
Tracer Techniques
Seminar (Public Health Administration)
Radiation Dosimetry and Shielding

Atomic Physics
Nuclear Physics
Organic Chemistry
Physical Chemistry
Mammalian Physiology
Research and Thesis

Doctor of Philosophy in Radiation Biophysics:

Advanced Radiation Biology
Radiation Absorption and Attenuation
Radiological Controls
Differential Equations and at least one additional course in mathematics (or statistics), a course in genetics, a second course of a year's sequence in physical chemistry, a course in biochemistry, a course in quantum physics or quantum chemistry, the departmental course in general biophysics and supplemental courses chosen in conformity with special interests of the student and with requirements of the student's advisory committee. The student must also present an acceptable dissertation based on a problem approved by his dissertation committee.

objectives

To provide a course of study covering all basic principles and processes of interaction between ionizing radiation and matter. The program constitutes a broad and comprehensive coverage of radiation physics and radiation biology which is essential to a career in Radiological Health Physics. At the same time, the student achieves training in depth in life processes. Special consideration is given to the preferences of the student by choice of courses and selection of a dissertation problem in conformity with his interests in radiation, physics, radiation biology, biophysics, radiological physics, health physics or radiological health. Opportunities are provided for practical experience through participation in the operations of a radiological health physics group which is responsible for the safe operation of a nuclear reactor, particle accelerators, cobalt 60 irradiators, and use of radiation sources and radioactive materials.

Address all communications to:

Frank E. Hoecker, Ph.D., Project Director
Department of Radiation Biophysics
Nuclear Reactor Center
University of Kansas
Lawrence, Kansas 66044

UNIVERSITY OF MIAMI

MIAMI, FLORIDA

graduate degrees

Master of Science degree with a major in Radiological Health or in Radiological Physics. Doctor of Philosophy degree granted in cooperation with a basic science or medical science department with specialization in radiation.

prerequisite

The candidate must present a bachelor's degree or its equivalent from an accredited college or university with major courses in the biological or physical sciences or in engineering. A satisfactory score on the Graduate Record Examination is required.

curriculum

Radiological Physics
Advanced Radiological Physics
Radiation Biophysics
Radiological Health and Protection
Nuclear Radiation Instrumentation
Radiological Sciences Laboratory
Special Work in the physical principles of diagnostic radiology, nuclear medicine, and clinical radiation therapy
Radiation Biochemistry
Radiation Dosimetry
Environmental Radioactivity
Special Problems in Radiology
Radiological Engineering
Seminar
Principles of Public Health Engineering
Biometry

Computer Programming applicable to Radiology
Nuclear Engineering
Radioisotope Techniques

Electives available in other departments and schools depending upon the qualifications of the student and his special field of interest.

The course and field work are scheduled to allow qualified students to complete the Master of Science program in 12 months. Depending upon the interests and background of the student, the work may be extended into the second year.

The doctoral degree program is provided on a cooperative basis with other departments within the university. Qualified students who have completed work in radiological health, radiological physics, or in related fields at other institutions will be considered.

objectives

The program in radiological health is designed to train professional personnel in this highly specialized field of public health to assess and control radiation hazards resulting from the widespread use of nuclear energy in science and technology, x rays, radium and other sources of ionizing radiation. Emphasis is placed on preparing candidates for service in public health agencies, medical facilities, and institutions.

The curriculum includes lectures, laboratory exercises, demonstrations, seminars, and field surveys to provide the student with the basic and practical knowledge needed in radiological health. Maximum benefit is derived from work in the Department of Radiology in the diagnostic, radiation therapy, nuclear medicine, and physics divisions. Operational health physics experience will be available with on-the-job training opportunities utilizing facilities at two nearby, large, nuclear power reactors. Field radiological problems are undertaken with the cooperation of local and State public health agencies.

Address all communications to:

Dr. Maxwell Dauer
Professor and Director
Division of Radiological Physics
Department of Radiology
University of Miami School of Medicine
Miami, Florida 33136

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN

graduate degrees

Master of Science; Master of Public Health; Doctor of Philosophy in Environmental Health

prerequisite

At least a bachelor's degree in physics, biology, chemistry, engineering, or other acceptable field.

curriculum

Thirty-six credit hours of course work are required for the degree Master of Public Health; a minimum of 30 hours for the degree Master of Science. Courses include biology, chemistry, engineering, mathematics, and physics. Required course work depends on the applicant's past experience and the degree program elected, but radiological health students are expected to satisfy the major fraction of degree requirements in the Department of Environmental Health. Master's degree candidates are encouraged to complete a small research project.

Programs leading to a doctorate in Environmental Health are designed to meet the needs of each individual. Emphasis is placed on the individual's ability to delineate and complete a research project of his choice. There are no specific course requirements for the doctorate; the student is guided by a faculty committee. Satisfactory completion of one foreign language, preliminary and final oral examinations are required.

objectives

The purpose of these programs is to provide professionally capable persons who can fill responsible radiological health positions in universities, public health agencies, and industry. The interdisciplinary nature of the radiological health programs at the University of Michigan enables students to become familiar with both the pure research and radiological health aspects of major facilities that use sources of radiation. These facilities include a large hospital, reactor, cyclotrons, kilocurie irradiation facilities, radioisotopic laboratories, and x-ray generators.

Address all communications to:

Professor G. Hoyt Whipple
School of Public Health
University of Michigan
Ann Arbor, Michigan 48104

UNIVERSITY OF MINNESOTA

MINNEAPOLIS, MINNESOTA 55455

graduate degrees

Master of Public Health
Master of Science
Doctor of Philosophy

prerequisites

A bachelor's degree in one of the sciences or in engineering is the basic prerequisite for admission to graduate programs. Students who are interested in earning the M.S. or M.P.H. degree should have mathematics through integral calculus and physics, including atomic and nuclear physics. Appropriate mathematics and physics courses are available on campus for those who require additional preparation in these subjects.

Applicants for the M.P.H. degree should have, in addition to the above admission requirements, either 1 year of graduate work in a field relating to public health or a minimum of 3 years experience in the public health field, or be a graduate of an approved school of medicine, dentistry, or veterinary medicine.

Candidacy for the Ph.D. implies completion of a Master's degree or the equivalent in training or experience. The Ph.D. involves either basic or applied research. A definite research interest is one of the primary considerations in reviewing an application for admission to a program of study leading to the Ph.D. degree.

curriculum

For the optimum scheduling of courses, it is advisable for Master's students to begin their studies at the beginning of the second term of Summer Session, about mid-July. The Master's programs require a minimum of 1 full year of study, including field training; however, students without previous experience or graduate study should plan a 2-year program.

Master's students usually spend one summer acquiring practical experience in radiological protection activities. Field work can be arranged with the Minnesota State Health Department, the University Health Service, nuclear power stations, laboratories of major contractors of the U.S. Atomic Energy Commission, or U.S. Public Health Service laboratories.

Although no definite amount of prescribed work is required for the Ph.D., the first year of study is usually devoted to completion of course work. Strong minors or supporting programs are encouraged in areas such as biology, biometry, biophysics, chemistry, epidemiology, mathematics, nuclear engineering and physics. A minimum of 3 academic years (9 quarters) in approved subjects, thesis research and writing is required to complete the Ph.D. if the applicant has no previous graduate study to his credit.

Broad and intensive courses are offered to prepare students for positions in professional practice, administration, and research. The curriculum can be adapted to any of a number of interests in view of the variety of academic capabilities available on the closely knit campus. Opportunities for interdepartmental programs of work and study are readily arranged.

Formal courses of special interest to radiological health students include, but are not limited to the following:

Biomedical Computing
Biophysics
Climatology
Electrical Measurements
Elements of Mathematical Biology
Elements of Public Health
Environmental Radioactivity
Epidemiology
Industrial Hygiene Engineering
Industrial Safety
Introduction to Air Pollution Problems
Introduction to Biometry
Low-Level Radioactivity and Radiation Measurements
Nuclear Reactor Design
Physiochemical Methods of Analysis
Principles of Modern Physics
Principles of Particle Technology
Public Health Administration
Quantitative Mammalian Biology
Radiation Dosimetry
Toxicology

objectives

The primary objectives of training programs in radiological health are:

1. to produce graduates capable of thinking for themselves;
2. to integrate the broad spectrum of knowledge required of the Health Physicist into a logical pattern directed toward understanding the implications of and control methods associated with protection of man from radiation hazards;
3. to provide the training necessary to prepare students in the health sciences for responsible leadership in health agencies and health related industries; and
4. to stimulate new ideas in both applied and pure research in Radiological Health.

Address all communications to:

Dr. Donald E. Barber
Associate Professor
Environmental Health
1112 Mayo Memorial Hospital
University of Minnesota
Minneapolis, Minnesota 55455

NEW YORK UNIVERSITY MEDICAL CENTER

TUXEDO, NEW YORK

(Institute of Environmental Medicine)

graduate degrees

Master of Science and Doctor of Philosophy in Radiological Health

prerequisite

A bachelor's degree in science or engineering including a demonstrated proficiency in physics and mathematics.

curriculum

Radiological Health
Radiological Physics
Radiation Hygiene Measurements
Radiation Hygiene Measurements Laboratory
Radiochemical Analysis
Environmental Radioactivity
Seminar in Environmental Radioactivity
Probability and Statistical Inference
Statistical Methods
Radiobiology
Analytical Chemistry of Environmental Contaminants
Microclimatology and Dispersion of Pollutants

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Environmental Contamination
Biological Effects of Environmental Toxicants
Environmental Hygiene Laboratory

Also pertinent courses offered by the Departments of Nuclear Engineering, Civil Engineering, Physics, Mathematics, Meteorology, and Biology

A Master's student completes either a Master's Thesis or a summer problem course.

objectives

The Laboratory for Environmental Studies of the Institute of Environmental Medicine is a research and teaching laboratory concerned primarily with the study of the sources of human exposure to radation and other environmental contaminants. The primary emphasis is on ionizing radiations, but research involving other radiations, such as mircrowaves, is also underway.

Typical research interests of the laboratory include studies of environmental radiation, such as natural radiation exposures in high-background areas (Brazil), movement of radioisotopes through the biosphere both artificial and natural. Causes of elevated cesium 137 in milk are being investigated in tropical areas; health hazards associated with uranium mining are under investigation; the metabolism of lead 210 in man and primates is under intensive study; and continuing radioecological studies of the Hudson River are in progress.

Many of the studies are undertaken through collaborative arrangements with municipal and State Health departments, and with the cooperation of industrial plants utilizing ionizing and other radiations. Much of the research and teaching program is designed around field problems.

The laboratory is located on a new University owned area in Sterling Forest, Tuxedo, N. Y., about 45 miles from New York City. Housing is available onsite for single or married students.

Address all communications to:

Dr. Merril Eisenbud
New York University Medical Center
Institute of Environmental Medicine
550 First Avenue
New York, New York 10016

UNIVERSITY OF NORTH CAROLINA

CHAPEL HILL, NORTH CAROLINA

graduate degrees

Master of Science, Master of Public Health, Master of Science in Sanitary Engineering, Master of Science in Public Health, Doctor of Philosophy

prerequisite

A bachelor's degree with a 3 grade point average in mathematics and the natural sciences. A bachelor's degree in engineering for Master of Science in Sanitary Engineering applicants.

curriculum

Modern physics for environmental sciences
Radiation instrumentation
Radiological hazard evaluation
Biological effects of radiation
Radiation biophysics
Radiation hazard and protection
Physical measurements in radioactivity
Principles of epidemiology
Principles of statistical inference
Man and his environment
Air hygiene or industrial hygiene
Electives in reactor technology

objectives

Plans of study in radiological health and safety are offered by combining the resources of North Carolina State University at Raleigh and the University of North Carolina at Chapel Hill. Students with prior preparation in physics whose preferences are reactor safety and health protection will enter North Carolina State at Raleigh in the School of Physical Sciences and Applied Mathematics or the Department of Nuclear Engineering of the School of Engineering. Students with preparation in health sciences whose preference is the comprehension of the radiological health sciences as a part of environmental control will enter the School of Public Health of University of North Carolina at Chapel Hill in the Department of Environmental Sciences and Engineering. Students will have at least one term of course work at the school alternate to that through which he enters.

The Department of Physics and the Department of Nuclear Engineering on the Raleigh Campus have developed instruction and carried on research in nuclear physics and reactor technology for more than 20 years. There is a balanced series of courses from the undergraduate level through the doctoral level. All students entering under the Radiological Health and Safety Program may elect courses and participate in research for which he is prepared and which he can profitably undertake.

At the School of Public Health, the Department of Environmental Sciences and Engineering has students at the master's level and doctor's level in environmental and food protection, environmental chemistry and biology, air hygiene, and sanitary engineering-water resources. The courses in these areas are open to those entering the radiological health program. There is a wide range of school offerings in epidemiology, administration, and health sciences.

Among the research facilities are a 10-kW heterogeneous reactor, a natural uranium subcritical assembly, a 1-meV Van de Graaff accelerator, high-level irradiation sources, multichannel analyzers, and low-level counting systems. Joint studies with the National Environmental Health Sciences Center in the Research Triangle Park are underway.

Address all communications to:

Professor Emil T. Chanlett
Department of Environmental
Sciences and Engineering
University of North Carolina
Chapel Hill, N.C. 27514

Dr. Arthur Waltner or
Dr. Thomas Elleman
North Carolina State
University
Raleigh, N.C. 27607

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS

graduate degrees

M.S., Ph.D.

prerequisite

Bachelor's degree in the physical, chemical, biological, or engineering sciences, including mathematics through integral calculus. Admission into The Graduate School is based mainly on the applicant's academic record. In certain instances, a satisfactory score on the Graduate Record Examination may be required.

curriculum

1. Required courses (first year):

Radiological physics, lecture and laboratory
Radiation dosimetry, lecture and laboratory
Radiation health controls, lecture and laboratory
Radiobiology, lecture and laboratory
Public health engineering
Physiology
Biostatistics
Seminar in environmental health engineering
Seminar in radiological health administration
Research

Practicum in radiation health
Experimental reactor physics (2d year)
Surveillance of environmental radiation (2d year)

2. Electives:

Pertinent courses, some of which are listed below, that are suited to the individual's needs and interests within the broad context of radiation health.

Occupational health
Air pollution
Sanitary engineering
Nuclear engineering
Biomedical engineering
Digital computation
Analog computation and simulation
Biophysics
Biological sciences
Chemistry
Mathematics
Physics

objectives

1. To educate scientists and engineers in the role of radiation and nuclear energy in our developing technology and in the public health problems that arise as a consequence of the exploitation of radiation both as a tool and as an energy source.

2. To technically train these scientists and engineers to become competent specialists in radiological health who can cope with the new and unique health and safety problems that are associated with radiation technology.

Address all communications to:

Dr. Herman Cember
Technological Institute
Northwestern University
Evanston, Illinois 60201

OREGON STATE UNIVERSITY

CORVALLIS, OREGON

graduate degrees

Master of Science in Radiological Health, Radiological Physics, or Radiation Biology

prerequisite

Bachelor's degree in one of the pertinent areas of science or engineering, admission to the Oregon State University Graduate School and approval of the Director of the Radiological Health Program.

curriculum

1. Core Curriculum
    a. Fall term—biology and radiation, radiological health seminar, statistical inference, x-ray sources, radioactive tracer methods.
    b. Winter term—cellular radiation biology, radiological health seminar, statistical inference, x-ray measurements, seminar in public health administration, radiological physics.
    c. Spring term—vertebrate radiation biology, radiological health seminar, epidemiology, radiation dosimetry, x-ray applications.
    d. Summer term—techniques in field radiation surveys, thesis.
2. Electives

    The student may select 6-8 hours from approved electives in the field of his major interest, either in the life sciences and/or physical sciences.

3. Completion

The program may take 1 to 2 years for completion based upon the candidates background. A thesis is required.

objectives

The curriculum is designed on the basis that integration of related disciplines is the most effective way in establishing the capabilities of radiological health and radiological physics specialists. Close coordination is maintained among radiation biologists, radiation physicists, and public health personnel through frequent research conferences and seminars. The training program is located in the X-ray Science and Engineering Laboratory. Equipment available in the laboratory includes a 300-kVp x-ray machine; a 300 mA, 150-kVp x-ray installation with image amplifier, cine and TV presentation; a 200 mA, 125-kVp x-ray diagnostic radiographic and fluoroscopic unit; a 100-kVp beryllium window x-ray unit; dental x-ray equipment, multichannel analyzer, radiation measurement instruments, shop, and a laboratory for chemical and biological dosimetry. Some courses in the core curriculum use the facilities of the O.S.U. Radiation Center training reactor, high-power pulsed reactor and isotopic sources, and other courses use the facilities of the Computer Center.

Address all communications to:

Dr. E. Dale Trout
Professor of Radiological Physics
X-ray Science and Engineering Laboratory
Oregon State University
Corvallis, Oregon 97331

UNIVERSITY OF PENNSYLVANIA

PHILADELPHIA, PENNSYLVANIA

graduate degrees

Doctor of Philosophy

prerequisite

Bachelor's degree in Engineering or Physics. Other admission requirements as specified in the University catalog of The Graduate School of Arts and Sciences.

curriculum

The Radiological Health training program at The University of Pennsylvania is a part of the widespread activities of the Biomedical Engineering Department. Generally speaking, the program in biomedical engineering is designed to provide the student with the knowledge of basic topics in biology and engineering together with intensive training in specific areas of their interaction. The program of study follows the conventional curriculum for graduate work in biomedical engineering except that in the radiological health curriculum there is emphasis on radiological physics, health physics, statistics, and epidemiology. Course work, however, is largely shaped by the background in the interest of each individual student. Research work is done in the laboratories of the Department of Radiology in the University Hospital on problems of interest in radiological physics.

objectives

We believe that our students will be professionally competent to assume major responsibility anywhere in the area of radiation health, but we believe it is most likely

that they will work professionally in large medical centers. In these positions they will fulfill a pivotal role in the radiation health of the general population through at least three aspects of their work: (1) the responsibility for direct influence on the optimum utilization of radiation producing equipment in the institution, as well as radiation safety problems in the use of radium and other radioactive isotopes; (2) research and development in new extensions of diagnostic x-ray apparatus and in the study and analysis of the quality and information content of the visual and radiologic image to optimize further the ratio of information to patient dose; (3) teaching of the elements of radiological physics and radiation safety to the many professional and technical groups for whose education a medical center assumes responsibility.

Address all communications to:

John Hale, Ph.D.
Department of Radiology
Hospital of The University of Pennsylvania
3400 Spruce Street
Philadelphia, Pennsylvania 19104

UNIVERSITY OF PITTSBURGH

PITTSBURGH, PA. 15213

graduate degrees

Master of Public Health, Master of Science (Hygiene), Doctor of Philosophy, and Doctor of Science (Hygiene)

prerequisite

Candidates should be either (1) holders of the degree of M.D. or equivalent degree, from an acceptable institution; or (2) holders of bachelor's degree with adequate training in the natural sciences or engineering; or (3) holders of the bachelor's degree qualified in some professional capacity to pursue graduate education in radiation health.

curriculum

Health Physics
Radiobiology
Reactor Hazard Evaluation
Field Problems and Training
Advanced Topics in Radiation Health
Biostatistics
Epidemiology
Radiation Health Seminar
Electives

Field Training.

Training at a number of industrial and clinical installations in this geographic area are used to provide a broad and varied field experience in the technological and the administrative areas of nuclear technology.

Electives.

Choice of electives include other courses required for the various degree programs.

It is possible to complete a master's degree within the 11-month academic year.

objectives

Education of graduate students to function as operating personnel, research investigators and teachers in the recognition, prevention, and management of health problems associated with radiation in:

(a) The nuclear industry worker population exposed to the occupational environment;
(b) The general population exposed to the aquatic and terrestrial environment;
(c) The patient population exposed to medical diagnostic and therapeutic applications of radiation;
(d) The clinical population in whom potential or actual radiation injury or radioactive contamination has occurred.

The present program includes training and research in six interrelated subspecialty areas: radiobiology, health physics, radiation chemistry, radiation medicine, radiation ecology, and radiological physics and engineering. Activities of the division are carried out in the Graduate School of Public Health; in a three-story Radiation Center utilized jointly with the Department of Radiology of the School of Medicine; and in a low-level, whole-body radiation facility and a clinical cytogenetics laboratory located in the Radiation Medicine Department of the University's teaching hospital.

Program faculty background covers the fields of radiological and health physics, nuclear medicine, radiobiology, radiation chemistry, and nuclear engineering. In addition there is related supporting faculty competence in industrial medicine, industrial hygiene, environmental physiology, and toxicology, as well as sanitary engineering including water chemistry, aquatic biology, and air pollution control.

Didactic and laboratory training is combined with clinical, field, and research work appropriate to student background and interests.

Scope of Research Program:

(a) In-vitro laboratory experiments: Radiation chemical studies of hemocyanin, radiation chemistry and radiobiology (microbiology and cytogenetics) of irradiated growth medium;

(b) In-vivo laboratory animal investigations: Hematology and cytogenetics of post-irradiation, viral and chemical leukemogenesis in the RF/Up mouse, lung clearance mechanisms for radioactive particulates in the rat;

(c) Human clinical studies: Dosimetric analysis and metabolic study of human radionuclide body burdens, dose-response relationships of human radiation-induced cytogenetic aberrations;

(d) Human population surveys: Correlation of mortality experience with radiation exposure in the nuclear industry worker population;

(e) Engineering and computer research and development projects: A biomedical image processing program leading to automatic cytogenetic analysis as population monitoring technique, and to diagnostic x-ray dose reduction by high-resolution electronic image amplification.

Address all communications to:

Dr. Joseph A. Watson
Radiation Health Division, A-512 GSPH
University of Pittsburgh
Pittsburgh, Pa. 15213

PURDUE UNIVERSITY

WEST LAFAYETTE, INDIANA

graduate degrees

Master of Science, Master of Engineering, Master of Science in Civil Engineering, Master of Science in Bioneucleonics, Doctor of Philosophy.

prerequisite

Possession of a bachelor's degree in engineering or one of the sciences and fulfillment of graduate school requirements for admission.

curriculum

A minimum of 24 semester hours of course work in addition to a thesis are required of each master's degree candidate. The course work is classified into one 12 semester hour major and 12 semester hours of related areas. Although required course work depends to some extent on the student's background and experience, a basic core of courses would normally include:

Health Physics
Health Physics Laboratory
X-ray Health Physics
Radiation Biology
General Bionucleonics
Bionucleonics Laboratory
Advanced Bioneucleonics
Environmental Surveillance

Environmental Sanitation
Public Health Engineering
Industrial Waste Treatment
Statistical Methods
Seminar or Field Trips or Equivalent

The course work for the Doctor of Philosophy degree is flexible and can be altered to meet individual needs. In general, 24 semester hours of course work in addition to that completed for the master's degree is required of each candidate. Courses in nuclear physics, nuclear engineering, biochemistry, biophysics, pharmacology, radiochemistry, biological sciences, chemistry, pharmacal sciences, and veterinary science are available to program participants. Research problems available for the Ph.D. thesis are broad in scope because of the wide diversity of interest among the staff members directing graduate research. Little difficulty is encountered in the selection of problems of common interest to the student and to the staff.

objectives

The primary objective of the program is to train qualified personnel in the radiological health disciplines with the expectation that such individuals will later serve in radiation protection and control programs throughout the country.

Address all communications to:

Dr. John E. Christian
Department of Bionucleonics
Purdue University
Lafayette, Indiana 47907

Dr. James E. Etzel
School of Civil Engineering
Purdue University
Lafayette, Indiana 47907

RENSSELAER POLYTECHNIC INSTITUTE

TROY, NEW YORK

graduate degrees

Master of Science, Doctor of Engineering, Doctor of Philosophy

prerequisites

Bachelor's degree in engineering or one of the sciences, and acceptance by the graduate school for admission.

curriculum

The following courses (or their equivalent) are normally taken by trainees in the Radiological Health Program. Other courses may be elected.

Master's Degree

Radiation Biology
Physical Chemistry, or
  Chemistry for Environmental Engineers
Nuclear Chemistry, or
  Introduction to Nucleonics
Advanced Mathematics
Safety Controls for Nuclear Operations
Radiation Detection Instruments Laboratory
Master's Thesis, or Projects

Doctor's Degree

In addition to the core courses listed for the master's degree, the following courses, or their equivalent, are considered important:

Microbiology
Genetics and Evolution
Human Physiology
Limnology
Radiochemistry
Applied Atomic and Nuclear Physics
Public Health I and II
Unit Operations in Environmental Engineering
Unit Processes in Environmental Engineering
Atmospheric Pollution
Management and Planning for Pollution Abatement

During the summer following the first year's work, doctoral students are required to take a 10-week course in Health Physics at Brookhaven National Laboratory.

objectives

The interdisciplinary program in Radiological Health is offered as part of the Environmental Engineering Curriculum. As a consequence, the students of Radiological Health are in direct contact with students and staff of all the cooperating departments of the Schools of Science and Engineering.

The curriculum is intended to prepare well-qualified students for useful careers of teaching, research, or professional practice in areas related to radiological health activities.

Address all communications to:

Dr. William W. Shuster
Bio-Environmental Engineering Division
Rensselaer Polytechnic Institute
Troy, New York 12181

RUTGERS: THE STATE UNIVERSITY

NEW BRUNSWICK, NEW JERSEY

graduate degrees

Master of Science, Doctor of Philosophy

prerequisites

A bachelor's degree in physics, biology, chemistry, engineering, or other acceptable field, and acceptance for admission in the graduate school.

curriculum

First Year, Normal Sequence

Fall Semester

Introduction to Radiation Biology
Introduction to Radiation Interactions
Radiation and Radioactivity
Fund of Radiation Instrumentation
General Environmental Sciences
Environmental Toxicology and Epidemiology
Radiation Science Seminar

Spring Semester

Radiation Biology
Introduction to Radiation Chemistry
Spec. Topics Radiological Health
Radiation Instruments and Dosimetry
Air Sampling and Analysis
Radiation Science Seminar

Summer

Experimental Problems in Radiological Health.

Completion of the master's degree requires, in addition to satisfactory completion of the courses listed, the preparation of an expository or critical essay, and the passing of a final comprehensive examination.

Subsequent Years

Qualified students continuing their studies beyond the first year program will select additional courses that support the research chosen for the Ph.D. thesis. These courses will be primarily basic sciences and usually at the advanced level; in addition, candidates for the Ph.D. degree must complete language requirements and a preliminary examination. Areas of dissertation research include radiation physics, radiation chemistry, radiation biology, aerosol physics, and environmental radioactivity.

objectives

The program is designed to provide a broad education in the basic sciences upon which Radiological Health is built. The objectives are twofold: (1) train professional radiological health specialists who will be qualified for work in any area of the field; that is, public health, industry, research laboratories, hospitals, universities, and so forth, and (2) provide a broad scientific introduction to students who wish to continue their studies to the Ph.D. in order to fill teaching and research positions associated with radiological health.

Address all communications to:

Dr. A. Joel Kaplovsky, Director
Radiological Health Program
Department of Environmental Sciences
Rutgers University
New Brunswick, N. J. 08903

TEMPLE UNIVERSITY HEALTH SCIENCES CENTER

PHILADELPHIA, PENNSYLVANIA

(SCHOOL OF PHARMACY)

graduate degrees

Master of Science with a major in Radiological Health, Doctor of Philosophy with a major in Pharmaceutical Chemistry (Ph.D. thesis in Radiological Health)

prerequisite

A bachelor's degree in any of the sciences, such as pharmacy, chemistry, physics, biology, medicine, or engineering, and acceptance by the Director of Radiological Health Program and the Temple University Graduate School.

curriculum

Isotope Methodology
Health Physics
Radiation Biology
Environmental Radioassay
Biostatistics
Electronics
X rays
Radioecology
Epidemiology

Public Health Administration
Seminar
Field Experience

Completion of the M.S. program requires 12 months. A minimum of 36 semester hours of graduate credit (6 semester hours given for Field Experience training) are required of each master's candidate. For the master's candidate the language and thesis requirements are waived.

The course work for the Doctor of Philosophy with a major in Pharmaceutical Chemistry can be tailored to meet individual needs; however, the Ph.D. thesis must be on a subject directly related to Radiological Health.

objectives

The course is designed specifically for the training of specialists for positions in radiation protection and control programs in public health departments. Field experience is gained in the Radiation Safety Office of Temple University, in local hospitals and industries, nuclear research facilities, and the City of Philadelphia, Department of Health.

The resources of the University Health Sciences Center, including the Department of Nuclear Medicine in the Temple University Hospital, the Department of Radiology in the School of Dentistry, and the Department of Pharmaceutical Chemistry (Bionucleonics Division) in the School of Pharmacy, are utilized in the training program. A new building that will contain about 10,000 square feet for the Bionucleonics Division will be completed by September 1971.

Address all communications to:

Charles E. McGee, Ph.D.
Assistant Professor of Radiochemistry
Temple University
3223 North Broad Street
Philadelphia, Pennsylvania 19140

UNIVERSITY OF TENNESSEE

KNOXVILLE, TENNESSEE

graduate degrees

Master of Science, Doctor of Philosophy

prerequisites

B.A. or B.S. with a major in physics, and an adequate background in mathematics. It is expected that applicants will also have some background in biology. Applicants are urged to furnish scores from the Graduate Record Examination.

curriculum

The curriculum and degree requirements consist basically of the physics courses, language examinations, preliminary examinations normally taken by students seeking the M.S. and Ph.D. in physics. In addition, special courses such as Introduction to Radiation Physics, General Health Physics, Public Health Administration, Epidemiology, Vital and Medical Statistics, Special Seminars in Health Physics, Interaction of Radiation and Electrons with Matter, Radiation Biology, and Radiation Chemistry are included in the curriculum.

An important feature of this program is that candidates will spend their summer months at the Oak Ridge National Laboratory working on various programs in the Health Physics Division (for example, radiation physics and dosimetry, radiation ecology, waste disposal, and applied health physics). Practical experience and lectures provide an interesting and stimulating supplement to the academic work.

Dissertations will be written in the general field of radiation physics.

objectives

It is the aim of this program to provide graduate training to help meet an increasing national and international need (Public Health Agencies, Government laboratories, industry, universities, hospitals, and so forth) for persons broadly trained in Radiological Health Physics. Because of the proximity of the University of Tennessee to the Oak Ridge National Laboratory, and because of the close cooperation which has grown up between the Department of Physics and the Health Physics Division it is natural that the program described is strongly oriented in the direction of the physics of the interactions between ionizing radiation and matter, and that the degrees conferred are in physics.

Address all communications to:

Alvin H. Nielsen, Head
Department of Physics
The University of Tennessee
Knoxville, Tennessee 37916

TEXAS A & M UNIVERSITY

COLLEGE STATION, TEXAS 77843

graduate degrees

Master of Engineering (nonthesis), Master of Science (thesis), and Doctor of Philosophy

prerequisite

To be admitted, a student must have a bachelor's degree in one of the following fields: Engineering, Physics, Chemistry, Biochemistry, Biology, or Mathematics, including a full year of chemistry and biology, math through differential equations, and must satisfy the entrance requirements of the Graduate College. The Graduate Record Examination is also required for admission.

Deficiencies in prerequisites may be made up during the summer prior to enrollment or during the first semester after enrollment.

curriculum

Principles of Radiological Safety
Nuclear Measurement Laboratory
Statistics
Radiation Biology
Seminar
Practical Applications of Radiation Safety Principles (I)
Practical Applications of Radiation Safety Principles (II)
Radiological Safety and Hazards Evaluation

Nuclear and Radiochemistry
Nuclear Radiation Detection
Mammalian Radiation Biology
Public Health Administration
Principles of Epidemiology
Special Problems or Research

The above suggested curriculum is not fixed and may be altered by the student's advisory committee by the substitution of graduate courses from the supporting fields of physics, mathematics, engineering, biochemistry, chemistry, or biology according to the student's interest and area of specialization.

Completion of the master's level program requires three semesters. The doctoral degree program is available for qualified students who have completed work at the master's level. There are no specific course requirements for the doctor's degree; the student and the course plan are guided by a Faculty Committee. Satisfactory completion of language, preliminary, and final oral examinations is required.

objectives

The Health Physics Program at Texas A&M University is interdisciplinary and is administered by a committee representing the various contributing disciplines. The program stresses the basic fundamentals in training Radiological Health Physicists at the professional level. The flexibility of the program allows specialization in one or more specific area of the Radiation Health Physics field. In addition, students are brought into contact with the Health Physics support of research projects at Texas A&M's Nuclear Science Center pulsing reactor facility (TRIGA), the new 88-inch Cyclotron facility and numerous radioisotope laboratories. Texas A&M also has one of the most advanced Data Processing Centers in the Southwest. The experience gained in working with the professional staff in a wide variety of radiation safety operations is considered invaluable in the training of Radiological Health Physicists.

Address all communications to:

Dr. R. D. Neff, Director
Radiological Health Physics Program
Radiological Safety Office
Texas A&M University
College Station, Texas 77843

THE UNIVERSITY OF TEXAS

AUSTIN, TEXAS 78712

graduate degrees

Master of Science in Environmental Health Engineering and Doctor of Philosophy (based on radiological health specialty)

prerequisite

A bachelor's degree in engineering; a "B" average in all work at the junior and senior levels; satisfactory score on graduate record examination. Provisional admission under some circumstances may be obtained.

curriculum

Environmental health engineering
Nuclear engineering
Biological effects of ionizing radiation
Epidemiology
Water resources
Electives
Nuclear physics
Radiation hazards and protection
Radiochemistry
Statistics
Air resources
Seminars

The Master of Science in Environmental Health Engineering is based on 30 semester credit hours, including a thesis. The average time needed to complete the requirements for a Master of Science degree in Environmental Health Engineering is about 12 months. The Doctor of Philosophy degree is offered for those students who qualify and wish to pursue advanced graduate studies.

objectives

This program is designed to assist those students who wish to develop a basic understanding of radiological health problems that confront engineers working in environmental health engineering or other areas of engineering, such as nuclear engineering. Advanced study programs are available for those wishing to specialize in various areas of radiological health engineering. Supporting work in nuclear engineering, nuclear physics, radiochemistry, biochemistry, bioengineering, microbiology, zoology, and so forth, is available.

Oral and written examinations are required before a graduate may become a candidate for a Ph.D. degree.

A considerable amount of flexibility may be exercised by the candidate in choosing supporting courses.

Address all communications to:

Dr. Earnest F. Gloyna
Professor of Environmental Health Engineering
The University of Texas
Austin, Texas 78712

UNIVERSITY OF WASHINGTON

SEATTLE, WASHINGTON

graduate degree

Master of Science in Radiological Sciences

prerequisite

A bachelor's degree in a physical or biological science, or engineering with a grade record meeting the graduate school requirements.

curriculum

Radiochemistry
Biological effects of ionizing radiation
Radiation hazards analysis and control
Radionuclides in the environment
Radiation research seminar
Public health administration
Epidemiology
Radiation dosimetry
Radioactive tracers
Thesis research

(Plus curriculum A or curriculum B, as follows:)

A. *Physical Science Option*

Nuclear engineering
Nuclear physics
Nuclear instruments
Advanced study in the physical sciences

B. *Biological Science Option*

Physical chemistry
Introduction to modern physics
Introduction to nuclear physics
Advanced study in the biological sciences

Completion of the program will usually require 2 years.

objectives

Two options for the program leading to the Master of Science degree in Radiological Sciences are offered in order to satisfy the somewhat different requirements and interests of biological scientists and physical scientists or engineers. The Physical Science Option is designed to give the student advanced training in radiation physics and nuclear engineering, together with a broad background in biology, biophysics, chemistry, and other areas pertinent to radiological health. The Biological Science Option is designed to give the student advanced training in the biological sciences, together with instruction in radiation physics, physical chemistry, radiochemistry, radiation biology, and other areas pertinent to radiological health. Both options include courses which will instruct the student in nuclear physics; radiation dosimetry and shielding; nuclear instrumentation; radiochemistry; environmental radiation hazards; radioecology; and radiation biology at the molecular, cellular, organ, and organism levels. In addition, seminars are conducted by local and visiting scientists who are active in radiation research. Thesis research may be carried out in various university laboratories of the School of Medicine, College of Arts and Sciences, College of Engineering, or College of Fisheries.

Address all communications to:

Dr. Kenneth L. Jackson
Chairman, Radiological Sciences
University of Washington
Seattle, Washington 98105

YALE UNIVERSITY

NEW HAVEN, CONNECTICUT

graduate degrees

Master of Public Health, Doctor of Public Health

prerequisite

Candidates to be admitted for the Master of Public Health degree may possess either: (1) A graduate degree, from an acceptable institution, in a discipline relevant to public health or (2) A bachelor's degree, from an acceptable institution, with a substantial knowledge in a discipline revelant to public health either through study or experience, or a combination of these.

Candidates to be admitted for the Doctor of Public Health degree must hold a doctoral degree in one of the health professions or in the biological sciences, or an equivalent degree.

curriculum

The Master of Public Health program administered by the Department of Epidemiology and Public Health, School of Medicine, is of 21 months duration. The student essentially fulfills the public health requirements of the degree during the first semester. The majority of the remaining study is devoted to course work in the radiological sciences.

Recommended Courses

First Year

Introduction to Public Health
Biometry
Radiation Physics
Radiation Biology
Instrumentation
Radiochemistry
Control of Radiation Hazards
Seminars

Summer

Field Experience in Radiological Health

Second Year

Biostatistics	Public Health Engineering
Radiation Dosimetry	Radiation Research
Radiation Physics	Seminars and Electives

Each candidate for the Master of Public Health degree is required to present an essay based upon original study.

The curriculum for the Doctor of Public Health degree is established individually by the student's advisor and doctoral committee.

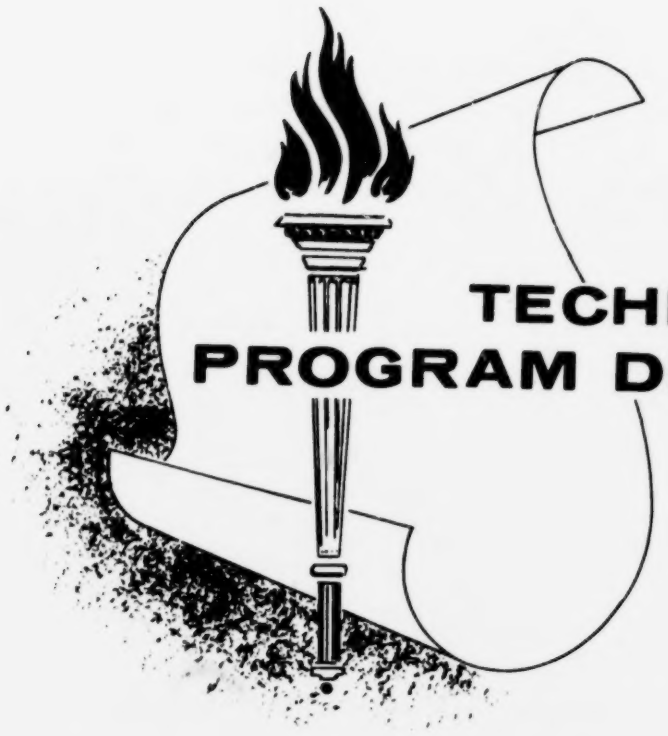
objectives

The purpose of the program is to provide radiological health specialists with substantial training in the principles of public health and biometry, in addition to intensive work in the several subspecialties of radiological health. This type of training will aid in the development of radiological health specialists who can work effectively as members of the public health team or as individuals on specialized projects.

Many of the University departments are utilized in the training program, such as the Departments of Molecular Biophysics, Physics and Radiology and the University Health Physics Division. Some of the specialized equipment at the University that is of interest to the program is the Electron, Heavy Ion and Van de Graaff Accelerators, high-voltage x-ray machines, multicurie cobalt installations, and various isotope facilities.

Address all communications to:

Mr. Eric W. Mood
Department of Epidemiology and Public Health
Yale University
60 College Street
New Haven, Connecticut 06510



TECHNICIAN PROGRAM DESCRIPTIONS

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CENTRAL FLORIDA JUNIOR COLLEGE

OCALA, FLORIDA

degrees

Associate of Arts in Radiological Health Technology

prerequisites

Graduation from an accredited high school or possession of a high school equivalency certificate. Transfer students from any other college or university are accepted provided the student is eligible to return to the last institution attended.

curriculum

A 2-year program, including one summer term.

I

General Education Courses

Chemistry
Humanities
American Institutions
Problems in Mechanics
Basic Electrical Phenomena
Engineering Drawing
Computer Programming I & II
Biology
English
Technical Mathematics I & II
Report Writing
Human Relations

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II

Radiation Courses

Introduction to Radiation Technology
Instrumentation Electronics
Radiation Physics I & II
Radiological Health Practice
Basic Radiological Health
Instrument Lab I & II
Biological Effects of Radiation and Medical Applications

objectives

The Radiological Health Technology program is designed to train technicians for beginning employment in fields of work directly related to or associated with nuclear activity. Successful graduates are qualified to assist health physicists and act as environmental radiation monitors in locations as diversified as medical research laboratories, nuclear power plants, isotope manufacturing industries, and nuclear ship manufacturing plants.

Address all communications to:

Director
Division of Applied Sciences
Central Florida Junior College
P.O. Box 1388
Ocala, Florida 32670

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

undergraduate degrees

Bachelor of Science in Medical Technology (Nuclear)
Associate of Science in Medical Radioisotope Technology

prerequisite

High School with 10 units of college preparatory subjects including one unit each of mathematics and science.

curriculum

Bachelor of Science

Freshman, Sophomore, and Junior years: College algebra and trigonometry, chemistry (inorganic, organic, analytical and biochemistry), foreign language, biology, anatomy and physiology, and physics plus required liberal arts courses and electives.

Senior year: Twelve-month hospital internship in the radioisotope and hematology laboratories of Cincinnati General Hospital.

Associate of Science

Freshman year: College algebra and trigonometry, chemistry, anatomy and physiology, English, and psychology.

Sophomore year: Twelve-month hospital internship in the radioisotope laboratory of Cincinnati General Hospital.

objectives

Bachelor of Science

The objective of the program is to train nuclear medical technologists who can supervise and train other persons to become nuclear medicine technicians.

Associate of Science

The objective is to train nuclear medicine technicians who can perform under supervision all of the current clinical diagnostic studies involving the use of radionuclides.

Address all communications to:

James G. Kereiakes, Ph.D.
Professor of Radiology (Radiologic Physics)
Radioisotope Laboratory
General Hospital
Cincinnati, Ohio 45229

LOWELL TECHNOLOGICAL INSTITUTE

LOWELL, MASSACHUSETTS

undergraduate degree

Associate in Science in Radiological Health Technology

prerequisites

Graduation from a recognized high school or equivalent study or achievement, with a minimum of 2 years of mathematics.

curriculum

General Requirements	*Core Subjects*
General Chemistry	Nuclear & Radiation Physics
Elements of Chemical Analysis	Applied Radiation Electronics
Mathematics	Radiation Detection Instrumentation
English	Radioisotope Techniques
Physics	Radiation Biology
Electricity & Electronics	Principles of Radiation Safety & Control
Biology	Environmental Radiation & Nuclear Site Criteria

The Associate in Science degree requires the completion of 90 credit hours of course work. Half of the course work involves preparatory study in the sciences with the remaining 45 credits in the core courses relating to Radiological Health. The program normally requires 5 years of evening school classes at the rate of 3 classes per week for completion. No fellowship or stipend support is available in this program.

objectives

The program leading to the Associate in Science degree in Radiological Health Technology is conducted through the Division of Evening Studies of Lowell Technological Institute with assistance from a U.S. Public Health Service training grant.

The program is designed to train high school graduates for careers in radiological health and to provide retraining for persons working in the field. It is designed to produce technologists with a basic understanding of the theory and techniques required of senior level radiation technicians.

Students enrolled in this program will enjoy the resources of a new $5 million nuclear facility at LTI. This includes a 5.5-MeV Van de Graaff particle accelerator, a 1-Megawatt swimming pool research reactor, hot cell facilities, radioisotope laboratories, and industrial radiography facilities.

Faculty and staff of the Nuclear Center who are active in radiological health or related fields provide qualified instruction for the core courses offered in the Radiological Health Technology Program.

Address all communications to:

Dr. Edward B. Van Dusen
Division of Evening Studies
Lowell Technological Institute
Lowell, Massachusetts 01854

MANHATTAN COLLEGE

RIVERDALE, NEW YORK

graduate degrees

Associate Degree and Certificate Program

prerequisite

A high school diploma with emphasis on mathematics and the sciences.

curriculum

The following curriculum is offered, there are no options or electives.

Biochemical Science I
Biochemical Science II
Mathematics I
Mathematics II
Mathematics III
Radiation Physics
Radiation Detection
Radiation Laboratory I, II
Radiation Control
Electronics
Electronics Measurement Lab.
Public Health

objectives

The Manhattan College Radiological Institute trains semi-professional personnel in a 2-year trisemester, evening program. Students are employed during the day in radiolog-

ical and nonradiological occupations. The program is designed to offer practical education of specialized study in radiation science. The courses provide realistic and intensive training on a broad basis, so that in addition to developing demand skills, the participant will not be narrowed, either in training or in the opportunity for further development and advancement. The courses of instruction provide the student with basic concepts of radiation, its capabilities and potential hazards, basic analytical techniques and intensive training in radiological laboratory procedures as applied to biological, chemical and physical systems. Graduates of the program are trained to collect data and undertake basic analysis of data with minimum supervision. The goal of the Institute is the practical education of personnel who will enter the fields of radiological health and science with a competency to immediately participate under professional guidance.

Address all communications to:

Dr. George J. Crowe
Physics Department
Manhattan College
Bronx, N.Y. 10471

MONTGOMERY COLLEGE

TAKOMA PARK, MARYLAND

graduate degree

Associate in Arts, Radiation Science

prerequisite

High School degree, competence in science

curriculum

Radiation Science

Freshman Year	*1st Sem.*	*2d Sem.*	*Sophomore Year*	*1st Sem.*	*2d Sem.*
Chem 101–102	4	4	Hum	3	3
En 101–102	3	3	PE 10–17	1	1
Math I–II	3	3	Phy 203–204	4	4
Psy 100	1		Pol Sc 101	3	
PE 10–17, 100	1	1	Rad Sc 211–212	4	4
Rad Sc 111–112	4	4	Soc 101		3
Zoo 121		4			

Radiation Technology

Freshman Year	*1st Sem.*	*2d Sem.*	*Sophomore Year*	*1st Sem.*	*2d Sem.*
ET 105–106	3	3	Chem 103	4	
En 101–102	3	3	Electives		6
Math I–103	3	3	Humanities	3	3
PE 10–17, 100	1	1	PE 10–17	1	1
Psy 100	1		Rad Sc 211–212	4	4
Rad Sc 111–112	4	4	Soc Sc 101–102	3	3
Zoo 121					

objectives

Radiation Science and Radiation Technology

Radiation Science and Radiation Technology

This program is designed primarily to prepare students for the increasing number of new occupations centered on the applications of nuclear energy and radioisotopes in industry and research. With an emphasis on the safety and control aspects of ionizing radiation and with a thorough introduction to the fundamentals of radiation physics and biology, completion of the program can lead to immediate employment as a Radiation Health Technician or Nuclear Science Aide. Employment opportunities are available in such areas as nuclear reactor sites, radiation biology research facilities, radiochemistry laboratories, and a variety of industrial complexes. Radiation Science is offered to enable students interested in transfer to continue studies toward advanced degrees in Biophysics, Radiochemistry, and Radiation Biology. Radiation Technology is a more technically oriented curriculum designed for immediate employment.

Address all communications to:

Alan K. Roecklein
Physics Department
Montgomery College
Takoma Park, Maryland 20012

OKLAHOMA STATE UNIVERSITY

STILLWATER, OKLAHOMA

(THE TECHNICAL INSTITUTE)

undergraduate degree

Associate Degree in Radiation and Nuclear Technology

prerequisites

High school diploma and acceptance by Oklahoma State University for admission.

curriculum

History and Fundamentals of Radiation
Public Health Aspects of Radiation
Environmental Radiation Fundamentals
Radiological Health I
Radiological Health II
Radiation Measurements
Radiation Biology
X-ray Radiation

Also specified basic courses in Math, Physics, Chemistry, Electronics, and in English and Humanities.

Completion of the program requires 2 years full-time study (4 semesters).

objectives

This program was established through the cooperation of Oklahoma State University and the U.S. Public Health Service. It is designed to supply qualified technicians for present and future employment in the field of nuclear science.

The courses are arranged to give the student a balance of understanding and manual skills, in a variety of applications of radioisotopes and radiation producing devices. The graduate is expected to be able to work as a technician in radiation related fields with brief on-the-job training.

The Radiation and Nuclear Technology Department has well-equipped laboratories for isotope preparation and counting, x-ray fundamentals, and modern physics. Additional facilities of Oklahoma State University available to the department include a multicurie cobalt irradiation facility and an AGN-201 reactor.

Address all communications to:

David A. Waite, Head
Department of Radiation and Nuclear Technology
The Technical Institute
Oklahoma State University
Stillwater, Oklahoma 74074

UNIVERSITY OF TENNESSEE

KNOXVILLE, TENNESSEE

undergraduate degree

Bachelor of Science with a specialization in Health Physics

prerequisites

Students in good standing, entering their junior year with an intent to major in physics are eligible for this cooperative program which leads to a bachelor's degree in Physics with a specialization in the Technology of Radiation Protection.

curriculum

Students in this curriculum must satisfy the standard requirements for a Bachelor of Science in the University of Tennessee. The technical courses recommended are ones which relate specifically to the general problem of radiation interaction with matter and introduction to health physics and biology.

Special core courses in Health Physics, Public Health Administration, Epidemiology, Biological Statistics, are included so that students will have a knowledge of the Public Health aspects of radiation protection. An important feature of this program is that the students will spend 3 full quarters in a practicum at the Oak Ridge National Laboratory Health Physics Division during which time they will have an opportunity to work in the practical aspects of the problems of radiation physics, dosimetry, radiation ecology, waste disposal, and general applied physics. During these 3 quarters they will take 9 credit hours of course work leading to graduation.

objectives

It is the aim of this program to provide undergraduate training in radiation protection to help meet the increasing national and international need for people competent in this field. With the increasing use of nuclear energy in industry and for power, and so forth, it will be necessary to train a greater number of people who are capable of managing the radiation protection of employees in these industries. It is believed that graduates from this program should be sufficiently well trained to be effective in this work. Such people should also be capable of supervising and giving on-the-job training to other people as the need occurs.

This undergraduate program was begun in June 1968 and is being supported by the Bureau of Radiological Health of the U.S. Public Health Service and provides its stipends for a number of undergraduates who wish to seek such technological training.

Address all communications to:

Dr. Robert J. Lovell
Department of Physics
The University of Tennessee
Knoxville, Tennessee 37916

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U.S. DEPARTMENT OF
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Public Health Service
Bureau of Radiological Health
Rockville, Maryland 20852

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